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ROYAL ONTARIO MUSEUM OF ZOOLOGY

BULLETIN No. 8

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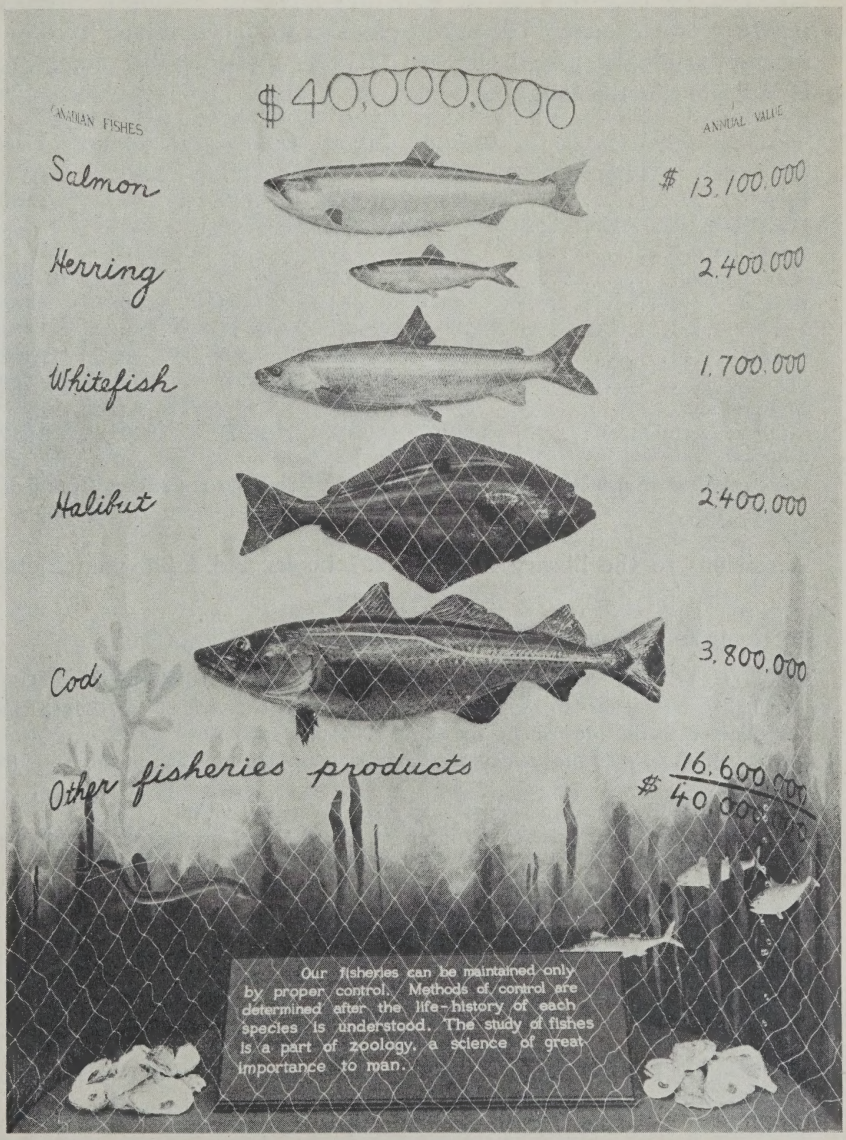


A RECENTLY INSTALLED EXHIBIT, ILLUSTRATING SOME OF THE MORE IMPORTANT COMMERCIAL FISHES OF CANADA

ACCESSIONS

Additions to the museum collections result chiefly from the work of museum field parties and from donations. Material necessary in connection with the study of certain problems which cannot be obtained by collection or by donation must be obtained through purchase or exchange. The extent of the materials obtained by these means during the period October 1, 1937, to September 30, 1938, is indicated in the following table:

	Donated	*Collected*	*Purchased*	*Exchanged*	*Total*
Mammals	500	1,140	164	72	1,876
Birds	1,453	842	612	62	2,969
Birds' eggs (sets)	58	36	0	30	124
Birds' nests	16	31	0	0	47
Amphibians	120	101	0	0	221
Reptiles	51	34	0	0	85
Fish*	706	461	17	0	1,184
Insects	9,082	8,110	0	0	17,192
Spiders	32	13,160	0	0	13,192
Molluscs and other invertebrates*	1,621	605	1,100	16	3,342

*In the case of fish and molluscs, the numbers given indicate the number of lots.

Accessions to the library included 207 books and 4,443 pamphlets.

Some of the outstanding donations were as follows:

Boggs, O. D. 289 bird skins and 4 sets of eggs from Peru and Ecuador. This makes a total of 445 bird skins from these countries which Mr. Boggs has donated to the Museum in the years 1936, 1937 and 1938.

Brodie, J. A. Nest of mockingbird. The first record of breeding in the Toronto region.

Brooman, R. C. 70 small mammals from the Waterloo vicinity.

Charlton, C. L. Magpie. This is probably the first Ontario specimen to be preserved.

Cook, Marshall A. Mounted sailfish.

Coventry, Prof. A. F. 54 small mammals and 1 bird's nest.

Dadisman, A. J. 59 bats.

Dear, Col. L. S. Set of Holboell's grebe eggs and set of Bonaparte's gull eggs. This is the first set of Bonaparte's gull eggs reported from Ontario.

Devitt, O. E. Nest and eggs of yellow rail, the first taken in Canada.

Doan, K. H. 359 lots of small fish collected in the Toronto region, 17 bats, 1 snake.

Ferguson, R. G. 19 birds from Moosonee, Ontario.

Foster, C. F. Cast of great auk's egg.

Hahn, Paul. Passenger pigeon, the 50th donated by Mr. Hahn.

Herrington, Rev. H. B. Large collections of flood debris containing great numbers of shells from Hastings County, a district hitherto unrepresented in our collection.

HOPE, C. E. 192 skins of birds, mostly from Credit Forks, Ontario.
KILBORN, Dr. L. G. 2 lesser pandas, also collection of land and freshwater shells from Chengtu, Szechan, China; our first land and freshwater shells from China.
LEARMOUTH, H. 38 bird skins representing 25 species from Somerset Island, North West Territories. This is our most northerly collection.
LUNN, W. H. 30 birds, 1 nest and 2 sets of eggs from Prince Edward County, Ontario.
MACGILLIVRAY, G. A. Diary of Charles Fothergill.
MACMILLAN, D. E. Ivory gull, probably the second to be preserved from Ontario.
MCILWRAITH, Estate of the late Thos. 12 mounted birds from the collection of the late Thomas McIlwraith, author of "The Birds of Ontario". This lot included a passenger pigeon, Mississippi kite and Eskimo curlew (the latter two new to the collection) and several others of especial interest.
NELSON, G. W. 2 fork-tailed petrels, new to our collection.
OSBURN, Prof. R. C. 8 species of fish from Ohio, not previously represented in our collection.
PERKINS, Sid. Champion airedale.
QUENTIN, Rev. A. P. and Peter. 130 skins of birds from West China.
RUTTER, R. J. 187 bird skins, 4 nests and 78 small mammals.
SHORTT, T. M. 187 skins of Manitoba birds.
SOUTHAM, H. H. 12 birds and 2 eggs from Pilgrim's Island, P.Q.
STEGGALL, Miss Winnifred M. Champion pug.
URQUHART, F. A. 1,340 miscellaneous insects.
WALLER, Sam. 61 birds, 3 nests, 22 sets of eggs, 10 mammals and box of shells.
WHELAN, R. V. 35 small mammals from Smoky Falls, 1 set of eggs, and 1 starling (the first to be taken from Smoky Falls).

FIELD WORK

One of the duties of the Royal Ontario Museum of Zoology is to make available information on the natural history of Ontario. While the general features of the animal life of the province are known, there are many blanks in our knowledge of the details of distribution. It is to round out this knowledge that parties from the museum carry on field work in various parts of the province each summer. During the past summer, work was carried on in the following areas:

Favourable lake region, Patricia District, Ontario. This is the first field expedition made by the museum to the vast area north of the transcontinental line of the Canadian National Railways. The expedition this summer was made possible by a grant from the Reuben Wells Leonard bequest. C. E. Hope, L. A. Prince and G. M. Neal spent ten weeks at the Berens River Mines Ltd., and made extensive collections of the mammals, birds, reptiles, amphibians, fish, insects, spiders, molluscs and other animal life of the region.

Lake Edward, Quebec. To understand certain features of the mammal life of Ontario, it is necessary to study specimens from farther east in Canada. In 1895 Outram Bangs and E. A. Bangs collected at Lake Edward, Quebec Co., P.Q., and described a number

of new forms, whose status is still in doubt. During the past summer, E. C. Cross and Stuart Downing, with Beverley Scott as assistant, spent two months at Lake Edward and neighbouring regions in Western Quebec, in order to secure material to throw further light on the characteristics of the mammals described for the area.

Timagami. J. G. Oughton continued his studies of the factors influencing the distribution of animal life in the Timagami area. This area is especially interesting for a study of this kind since it includes islands of widely different sizes and of quite different physical conditions.

Point Pelee, Ontario. This is the most southerly region of Canada and is therefore of special interest, since it contains animal life not found elsewhere in this country. F. A. Urquhart and T. B. Kurata spent some weeks in this area, their studies concerning especially the insects and spiders of the region.

Manitoulin Island. J. L. Baillie visited Manitoulin Island during June in an attempt to add to our knowledge of the bird life of this interesting region.

The Canadian Arctic. Through the invitation of the Administration of the Northwest Territories, T. M. Shortt was enabled to visit the eastern Arctic on the Canadian Government Patrol steamer "Nascopie". He secured 172 specimens of birds as well as bringing back many coloured and pencil sketches of birds.

MUSEUM EXHIBITION

Four of the new type exhibits mentioned in the last Bulletin have been completed. One of these, dealing with the Role of the Bird of Prey, was illustrated in Bulletin 7. Two others are illustrated in the present number of the Bulletin. The fourth one, entitled Nature's House that Jack Built, illustrates the biological principle of the food chain and the pyramid of numbers by means of specimens illustrating "This is the hawk (red-shouldered hawk) that eats the snake (two garter snakes) that eats the frog (four leopard frogs) that eats the hopper (sixteen grasshoppers) that eats the grass (thirty-two grass plants) that grows in the earth about us.

A specimen of Kerry Blue Terrier has been added to the collection of record dogs.

Other additions to the gallery exhibits include grizzly bear, grey timber wolf, mountain lion, kinkajou, marmoset monkey, Stone's mountain (black) sheep, and albino porcupine.

Two cases to be used in connection with the Museum's travelling exhibits were prepared as follows: Fine feathers make fine birds (seven brilliantly coloured birds), Birds of the night (seven Ontario owls).

A series of large-scale models of insects and other small animals is in process of construction. Those completed to date are the grasshopper (ten times natural size), woodlouse (twenty-five times natural size) and spider (fifty times natural size). Such models enable the average museum visitor, unaccustomed to examining such tiny creatures, to understand something of their structure.

The exhibits of living animals continuously on view is an attractive feature of the gallery. Living animals are always more interesting than ordinary museum specimens, but naturally there is a limit to the number of live specimens that can be included in a museum. The exhibits are changed from time to time so that in the course of a year, a wide variety of fishes, both native and tropical, frogs, salamanders, snakes, turtles, lizards, molluscs, crayfish, etc. are shown.

Temporary exhibits are placed in the gallery from time to time. Those arranged during the past year include an exhibit of nature photographs by local naturalists, an annual exhibit of tropical fish by the Toronto Aquarium Society, a display of tropical moths and butterflies, a group of animal drawings made in the gallery by students of the Western Technical School, an exhibit of nature projects by children, a display of Australian shells and specimens secured by the Museum's various summer expeditions.

WORK OF THE MUSEUM DIVISIONS

Mammals. Two chief projects are being carried on in the division of mammals. One is a study of the distribution and taxonomy of the mammals of Ontario: the other is the compilation of records of the changes in the numbers of mammals. Distributional and taxonomic studies involve the collection and comparison of series of skins from different parts of the country. In connection with this work 1,876 specimens were added to the collection during the past year. In addition to caring for these specimens, an effort is being made to overtake the arrears of cataloguing which had accumulated before the organization of the mammal work as a separate division.

Some account of the importance of population studies is included elsewhere in this bulletin. The accumulation of this information involves the distribution of questionnaires to hundreds of correspondents in Ontario and in other parts of Canada. Many of the records contained in these questionnaires are not immediately compiled; they are filed for future use in population studies of various kinds. A special inquiry into the deer population and the kill in different parts of the province has been undertaken and the results published in an article by Mr. Cross published in Rod and Gun under the title "The White-tailed Deer Crash".

Birds. The work of the bird division includes the collection, preparation, cataloguing and care of study specimens, mapping the distribution of birds in Ontario, taxonomic studies on special groups of Canadian birds and various types of educational work. The report of museum accessions indicates that nearly three thousand specimens of birds were added to the collection during the year.

Studies completed and reported on are indicated in the list of publications elsewhere in this bulletin. Studies of a similar nature are in progress. The division has also advised on the compilation of and undertaken the circulation of a questionnaire on the pileated woodpecker, for a study being made by R. D. Ussher and O. E. Devitt. This is the sort of co-operative study which we wish to promote with workers outside the staff. There are many problems of a similar nature which could be undertaken in the same way, by qualified workers under the supervision of the division.

A statistical study of birds, based on one of the museum files which contains more than 10,000 daily lists of birds seen in the Toronto region during the past fifty years, is being made by J. Murray Speirs. When completed, this work will give for all species of birds visiting the Toronto region the earliest date of arrival, the "peak" dates of spring and autumn migration and much other information of interest in connection with the ornithology of the Toronto region. These studies have also brought to light periodic fluctuations from year to year in the numbers of certain birds, which were not previously suspected.

A further aid to ornithological research has been rendered by the loan of specimens to workers in other institutions. Loans have been made to the following institutions during the year: Bureau of Biological Survey, Washington; National Museum of Canada, Ottawa; University of California.

Reptiles and Amphibians. There is great popular interest in reptiles, particularly snakes. This is reflected in the questions and requests for information that come to the Museum. This service is a legitimate function of the Museum but it sometimes interferes seriously with other Museum projects.

Requests for loan of specimens by scientific workers were fulfilled as follows: 248 toads were loaned to Graham Netting, Carnegie Museum; 22 fox-snakes were loaned to Roger Conant, Philadelphia Zoological Society; 40 British Columbia garter snakes were loaned to Professor J. R. Slater, College of Puget Sound.

A study of the status of *Rana cantabrigensis*, a northern wood frog, has been continued. This has involved the examination of 353 specimens loaned by the Museum of Zoology, University of Michigan.

A notable discovery by this division during the past year was the finding by E. B. S. Logier and W. J. LeRay of Butler's garter snake (*Thamnophis butleri*) in Ontario. This species, not previously known from Ontario, was found by Messrs. Logier and LeRay near Newbury, Middlesex County. Its range in the United States includes extreme western New York, western Pennsylvania, Ohio, Indiana, Michigan and a small area in southwestern Wisconsin. It is suspected that this is another example of a prairie species spreading into Ontario as our province becomes more prairie-like with the clearing of its forest cover. The red-barred garter snake (*Thamnophis sirtalis parietalis*), a western subspecies of our common garter snake, was discovered by the field party to the Favourable lake area of Patricia District. This is the first record of its occurrence in Ontario.

Fishes. One of the projects receiving special attention in the division of fishes is mapping the distribution of the different species of fish found in Ontario. This distribution is moderately well known for southern and central Ontario. During the past two years, special attention has been given to eastern Ontario. G. C. Toner of Gananoque again collected in that area. The fish life of Algonquin Park is being made known through the work of the Fisheries Research Laboratory of the Department of Biology, University of Toronto. The limits of the distribution of species northward and westward is one of the important problems remaining. In the case of game species such as speckled trout and maskinonge, information is occasionally secured from sportsmen, mining men and others who live or travel in that part of the province, but for the smaller forms collecting by museum parties is a necessity. The expedition to the Favourable lake area, Patricia District, contributed important information in this connection.

Our collection of the fishes of northern Canada has been increased through the receipt of specimens from Aklavik at the mouth of the Mackenzie river, from Eskimo Point on Hudson Bay and from other sources in the Arctic. The museum's collection is especially rich in coregonine and salmonoid fishes from northern Canada.

Insects and Spiders. The accession report indicates that 17,192 insect specimens were added to the collection during the year. These were distributed among the orders as follows: Orthoptera 7,135, Lepidoptera 1,319, Hymenoptera 923, Coleoptera 313, Diptera 122, Odonata 22, Trichoptera 15, Ephemeridae 11, Miscellaneous 7,332.

The insect collection has also been enriched by a number of additional paratypes and topotypes which have been obtained through

the medium of exchange. These include two topotypes and thirteen paratypes of Diptera received from Mr. D. Elmo Hardy of Brigham Young University, to whom the Division had loaned a collection of Bibionidae in connection with his researches; two paratypes of Saltatorial Orthoptera from the United States National Museum in exchange for two paratypes of *Nemobius;* two paratypes of Blattariae from the Academy of Natural Sciences, Philadelphia, in exchange for material sent to Mr. M. Hebard. The addition of such material to our collection is of great value, especially in view of further research on species indigenous to the province of Ontario.

In addition to answering questions concerning the identification of insects and the control of insect pests, submitted by visitors calling at the museum or by mail and telephone, the division of entomology has made contacts with the public through the medium of lectures.

The research carried on during the past year by the division concern chiefly Orthoptera. Attention is still being devoted to records of occurrence of *Celerio lineata* in Ontario. An account of an unusual immigration of this species was given in the last Bulletin.

The museum's fine collection of the spiders of Ontario is steadily growing. Many naturalists in different parts of the province have contributed specimens to this collection during the past year. Collections have also been made by museum parties. Knowledge of the distribution of spiders is not only of interests in itself but throws light on the factors influencing the distribution of Ontario life in general.

Conchology. Our collection of Ontario molluscs is rapidly growing through field work and donations. It is now reaching the stage where it is useful for research. Our serial register indicates more than 12,700 lots. Much more clerical work remains to be done, however. There are many uncatalogued lots—two collections obtained during the past year are still largely uncatalogued, together with the summer's field collection—and there is need of a card index.

Specimens were sent in exchange to the following institutions and persons (about five to six hundred lots altogether): Dr. H. A. Pilsbry, Philadelphia Academy of Sciences; University of Michigan; Museum of Comparative Zoology, Cambridge; C. L. Blakeslee and Mrs. Marie Callejo.

The study of land invertebrates begun in Timagami in the summer of 1937 was completed this past summer. This collection, together with the accumulated specimens in the Museum collection, will form the basis for a proposed study of the land molluscs of Ontario.

MUSEUM PUBLICATIONS

The following publications have been issued during the year:

CONTRIBUTIONS. Price twenty-five cents per copy.

12. Ontario and its avifauna, by L. L. Snyder, and The Museum's bird collection. by J. L. Baillie, 14 pages.
13. Birds of Algonquin Provincial Park, Ontario, by D. A. MacLulich, 47 pages.
14. A faunal investigation of Western Rainy River District, Ontario, by L. L. Snyder, 57 pages.

OCCASIONAL PAPERS. Price ten cents per copy.

4. The northwest coast sharp-shinned hawk, by L. L. Snyder, 6 pages.

Additional publications in journals.

CORFE, C. E. The praying mantis in Ontario. Can. Entomologist, Jan. 1938.
Unusual abundance of *Celerio lineata* in Ontario. Can. Entomologist, Feb., 1938.

CROSS, E. C. Antlers, how and why. Hunting and Fishing in Canada, Nov., 1937.
Synaptomys borealis from Godbout, Quebec. Jour. Mamm. Aug., 1938.
The white-tailed deer crash. Rod and Gun in Canada, May, 1938.

DOWNING, S. C. Second Ontario record for the pipistrelle. Jour. Mamm., Feb., 1938.

DYMOND, J. R. External parasites of bats. Can. Entomologist, Jan., 1938.

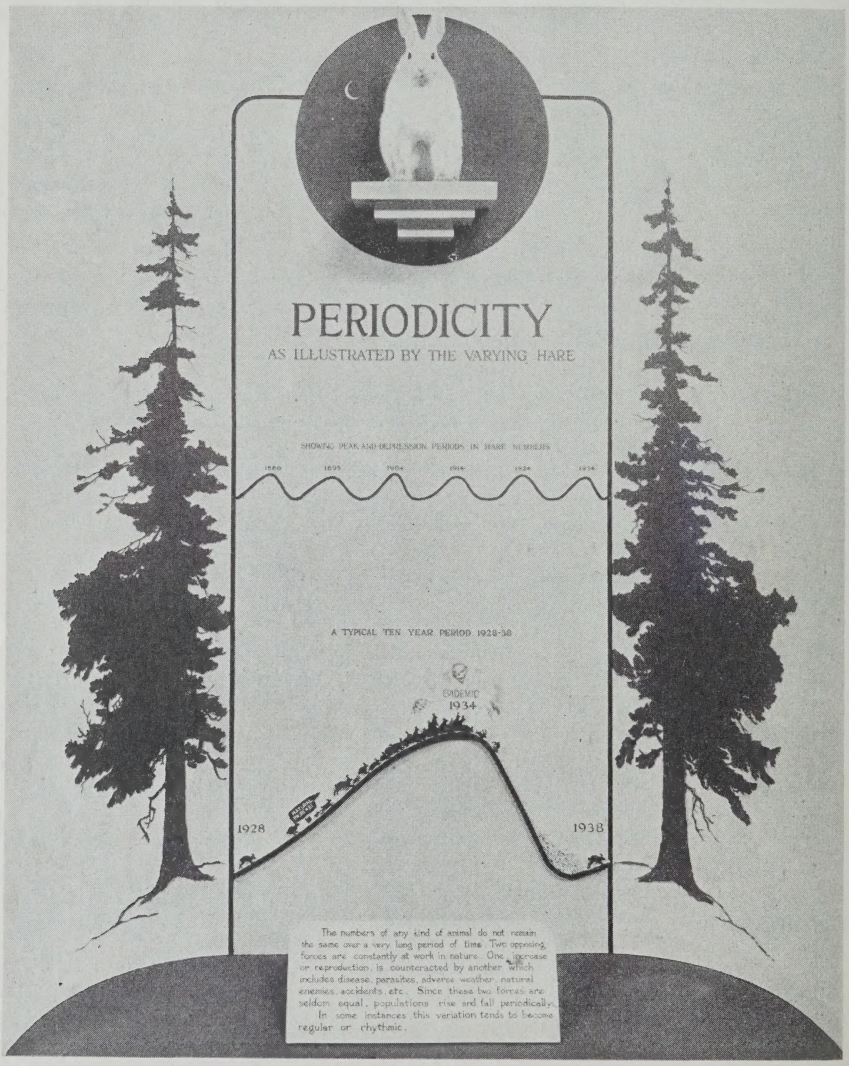
HOPE, C. E. (with L. L. Snyder). A predator-prey relationship between *Asio flammeus* and *Microtus pennsylvanicus*. Wilson Bull., June, 1938.

KURATA, T. B. The spiders of Mer Bleue, near Ottawa. Can. Field-Nat., Nov., 1937.

OUGHTON, J. G. (with A. LaRocque). A preliminary account of the Unionidae of Ontario. Can. Journ. Res., Aug., 1937.
Notes on *Hygromia striolata* (Pfr.) at Toronto, Canada. Nautilus, Apr., 1938.
Valvata piscinalis Müller in the Great Lakes. Nautilus, Jul., 1938.

SNYDER, L. L. An extralimital record of the magpie in Ontario. Can. Field-Nat., Mar., 1938.
An ivory gull from Oba, Ontario. Auk, Apr., 1938.
(with J. M. Speirs). On the status of the starling (*Sturnus vulgaris*) at Toronto. Can. Field-Nat., Nov., 1937.
(with C. E. Hope). A predator-prey relationship between *Asio flammeus* and *Microtus pennsylvanicus*, Wilson Bull., June, 1938.
Social systems in nature, Can. Science Digest, June, 1938.

URQUHART, F. A. Internal anatomy of the housefly, Can. Science Digest, June, 1938.
A new species of *Nemobius* from Ontario. Can. Entomologist, May, 1938.
The oviposition and cannibalistic habits of the narrow-winged katydid (*Phaneroptera pistillata* Brummer). Can. Field-Nat., Apr., 1938.
The insect collection of the Royal Ontario Museum of Zoology. Can. Entomologist, Apr., 1938.


PERIODICITY
AS ILLUSTRATED BY THE VARYING HARE
SHOWING PEAK AND DEPRESSION PERIODS IN HARE NUMBERS
1886
1895
1904
1914
1924
1934
A TYPICAL TEN YEAR PERIOD 1928-38
EPIDEMIC
1934
1928
1938
The numbers of any kind of animal do not remain the same over a very long period of time. Two opposing forces are constantly at work in nature. One, increase or reproduction, is counteracted by another which includes disease, parasites, adverse weather, natural enemies, accidents, etc. Since these two forces are seldom equal, populations rise and fall periodically. In some instances this variation tends to become regular or rhythmic.

A MUSEUM EXHIBIT ILLUSTRATING THE PERIODIC FLUCTUATIONS IN THE POPULATIONS OF THE VARYING HARE. PERIODS OF ABUNDANCE ALTERNATING WITH PERIODS OF SCARCITY RECUR WITH SURPRISING REGULARITY IN THIS ANIMAL. THE DATES INDICATED ON THE UPPER CURVE ARE 1886, 1895, 1904, 1914, 1924, 1934. THE LOWER CURVE ILLUSTRATES A TYPICAL TEN YEAR PERIOD,—INCREASE FROM SCARCITY TO ABUNDANCE WHEN EPIDEMICS BREAK OUT PRODUCING SCARCITY AGAIN.

THE STUDY OF ANIMAL POPULATIONS

Making a census of the people of a country and of their domestic animals and other possessions has long been a practice of civilized countries; more recently it has been found necessary to know something of the numbers of wild animals as well. Most people interested in wild animals are concerned largely with their numbers; if the animals are useful, we want to know how to have more of them, if injurious, we wish to have fewer. To the officials concerned with regulating the seasons and numbers of animals to be killed it is of prime importance to know the populations of the animals concerned.

Periodicity in Hare Populations

Many kinds of animals are known to vary widely in numbers from year to year. Perhaps the best known example of this is the varying hare (snow-shoe rabbit) *Lepus americanus* of the north woods of Canada. In our last Bulletin (No. 7) some account was given of the periodic fluctuations in numbers of this animal. This is illustrated graphically in a recent museum exhibit reproduced herewith. Every ten years, on the average, hares become scarce because most of them die of epidemic disease. In the next few years following their dying off they gradually increase in numbers until in seven or eight years they are abundant again. This abundance is maintained for a year or two and then epidemics begin to spread among them and soon they are scarce again as they were approximately ten years before. The years in which hares were last abundant in the Hudson Bay watershed before decreases set in were: 1856, 1864, 1875, 1886, 1895, 1905, 1914, 1924 and 1934 or 8 cycles in 78 years.

Hare Numbers Affect Life in the North

These alternate periods of abundance and scarcity of hares profoundly affect life throughout the northland. Indians cut the hides of hares into strips and weave them to make warm fur blankets. But such fur robes cannot be made every year. There are only a few years in every ten when there are enough hares to provide Indians with fur blankets. When hares are numerous there is never a shortage of food for although Indians may not depend on hares as a staple article of diet, they can fall back on them when other food is scarce, but they are hard pressed when hares too are scarce.

The Indians are not the only inhabitants of the north country to miss the hares. Many fur-bearing animals relish a hare dinner. The

lynx lives on almost nothing else, while the fox, wolf, weasel and most other flesh-eating animals eat large numbers of hares when they are to be had. Birds such as the great horned owl and goshawk prey on the hare too. But it is not these natural "enemies" that lead to the scarcity of hares. The latter increase in spite of all the predators that prey on them. In fact as the hares continue to increase, the lynx, fox, horned owl and goshawk increase too, since with an abundance of food in the form of hares, more young lynxes, foxes, etc. are born and survive. As the hares approach their peak of abundance, there is general prosperity in the north woods, but when epidemics reduce the hares to scarcity the animals dependent on them for food also grow scarce. Records of the fur trade indicate that such furs as the lynx and fox rise and fall in abundance with periodic abundance and scarcity of hares.

Emigration of Birds When Hares Die Off

The disappearance of the hares is felt far from the north woods in which they live; such birds as the goshawk which increase in numbers as the hares increase, is not content to remain in his northern home and starve, but moves out presumably in search of food. In the winter or two following the disappearance of the hares, goshawks occur in conspicuous numbers in the south. Thus in southern Ontario these large hawks have been seen in some numbers in the winters of 1896-7, 1906-7, 1926-7, 1934-5. The lynx and fox is believed to wander to some extent in search of food when the hares have died off but the range of their movement is not nearly as great as that of the birds.

Prey Numbers Affect Predator Numbers

A point worth emphasizing in connection with the fluctuations of hare numbers is that it is not the "enemies" of hares which cause their scarcity; the reproductive capacity of hares and other animals is adequate to maintain and even increase their numbers in the presence of the predators which normally prey on them. It is the prey, in this case the hares, which determine the numbers of their predators. Predators do affect to some extent the numbers of their prey but the initiative lies with the prey.

Lemming Fluctuations and Migrations

Another animal whose numbers rise and fall from teeming abundance to scarcity is the lemming. There are several kinds of

lemmings, but all are large, long-haired relatives of the meadow mouse and all live in the Arctic regions. Their peaks of abundance occur at four year intervals on the average. Unlike the hares, lemmings do not remain at home and die of epidemics; when they become crowded through population pressure, the lemmings migrate away from their homelands. In Scandinavia these periodic lemming emigrations have been spectacular occurrences for hundreds of years. "The lemmings march chiefly at night, and may traverse more than a hundred miles of country before reaching the sea, into which they plunge unhesitatingly and continue to swim on until they die." By such wholesale emigrations their crowded numbers are reduced to more normal proportions.

Lemming migrations have not been a conspicuous feature of the Canadian Arctic although alternating periods of great abundance and scarcity are known to occur usually at four year intervals. Just as lynx, fox, horned owl, goshawk and other animals that feed on hares show the same periods of scarcity and abundance as the hares, so the animals that feed on lemmings in the Arctic are alternatingly abundant and scarce every four years on the average following the ups and downs of the lemming population.

Lemming Numbers Affect Arctic Fox and Snowy Owl Numbers

Snowy Owl

The Arctic fox and the snowy owl are two animals whose population numbers appear to be controlled by the lemming populations. With plenty of lemming to eat, Arctic foxes and snowy owls increase in numbers and become abundant too. When lemmings get scarce there are a lot of hungry foxes and owls and, just as goshawks come south approximately every ten years following the disappearance of hares, so snowy owls come south more or less at four year intervals when lemmings get scarce. Below are given in parallel columns the years in which Arctic fox pelts were traded in largest numbers at Fort Chimo in Ungava peninsula, and when snowy owls were seen in southeastern Canada and neighbouring parts of the United States.

Arctic Foxes abundant	*Snowy Owl migrations*
1882	—
1887	—
1890	—
1893	—
1897	—
1901	1901–02
1905	1905–06
1909	—
1913	—
1917	1917–18
1921	—
1926	1926–27
1930	1930–31
1934 ?	1934–35

The fur returns of the Bureau of Statistics show that 1934-5 was the biggest white fox year since 1930-31.

That Arctic foxes sometimes emigrate in numbers at times of peak abundance is indicated by the occurrence of thousands of Arctic foxes far to the south of their normal range in southern Labrador in April and May, 1922. One was shot on Cape Breton Island in April, 1923. This southern movement of Arctic foxes was probably related to the disappearance of lemmings following the peak which gave rise to the abundance of foxes at Fort Chimo in 1921.

Fluctuations in Mouse Populations

The mice of more temperate regions also fluctuate widely in numbers from year to year. White-footed mice or deer mice (*Peromyscus*) in some years swarm in the forested regions of Central Canada. Meadow mice or voles (*Microtus*) occasionally reach plague proportions also. Other species, including the red-backed vole and jumping mice are known to occur in widely different numbers from year to year. Not enough information has yet been accumulated about the years and places in which these mice reach peak numbers or become scarce. We do not know for certain, therefore, whether the fluctuations in numbers of any of these mice are periodic or not in Canada.

These mice are of considerable economic importance and it is therefore essential that we attempt to understand the laws governing their changes in numbers. When meadow mice were abundant across southern Ontario they caused great injury to young orchards and to shrubbery as well as to crops especially to corn left standing in the stook in fields. In other areas they are of economic advantage. Several species of mice for instance are known to be of considerable importance in the control of spruce sawfly and larch sawfly because they eat the cocoons of these insects. Mice too form the staple food of

many fur-bearing animals. Thompson Seton has written, "What moss is to the reindeer, what grass is to the cattle, the mouse millions of the north are to all the northern carnivores from bear to *Blarina* (mole shrew). When we shall have fully worked out the life history of each of these species, I believe we shall learn that the whole of that vast, beautiful, important and specialized production that we call the Carnivora rests on a broad, simple basis of Muridae (mice), that in turn rests on the grass, that rests on the earth. We shall for each of these flesh-eaters write, 'it sometimes eats this and sometimes eats that, but by far the greatest bulk of its food is mice' ".

Periodicity in Grouse Populations

Cycles of abundance and scarcity are not confined to hares, lemmings, mice and the fur-bearing animals and flesh-eating birds that prey on them. Game birds such as the ruffed grouse and sharp-tailed grouse are known to be abundant and scarce in fairly regular cycles of much the same length as those of the hares. In Ontario, ruffed grouse suffered serious diminutions in numbers in 1874, 1883-4-5, 1894-5, 1904-5-6, 1914-5-6, 1924-5, 1933-4-5. Following each of these periods of scarcity grouse recovered and were numerous for a few years prior to their cyclical disappearances. It has recently been shown that periodic diminution of grouse numbers is due to epidemics of disease as in the case of hares. In the fall of 1932 Ontario was visited by large numbers of sharp-tailed grouse. This movement is believed to have represented an emigration of these birds, caused by an unusual abundance of them in their normal homes farther north.

Peaks of Abundance in Different Years at Different Places

There is space in this brief account of animal populations to mention only one additional feature of these periodic fluctuations, namely that peaks of abundance do not always occur in the same year in all parts of the country. In the case of grouse and hares there is often a spread of three or four years between the time maximum numbers are attained in one part of the country as compared with another. Different areas may have mouse plagues in different years; for instance southern Ontario had a plague of meadow mice in the fall of 1935; in northwestern Ontario, the maximum numbers were not attained until 1937.

Value of Understanding Population Changes

As information on changes in the numbers of animals accumulates, it is becoming evident that many more species of wild life than was

originally suspected are characterized by these regular periodic fluctuations in numbers. The importance of understanding the nature and causes of these fluctuations can hardly be over-emphasized. Their importance in the fur trade has already been indicated. It is too early in these studies yet to say whether anything can be done to control them, but whether we can control them or not it is of value to know that next year or five years from now certain animals will be scarce or abundant. Such knowledge is of special importance to officials concerned with making regulations for open and closed seasons, bag limits, etc.

The Museum and Population Studies

For several years the museum has been accumulating information on changes in the numbers of animals from year to year. This is made possible through the co-operation of many hundreds of correspondents scattered throughout Canada to whom we are deeply indebted for assistance in this work.

In studies of this kind the longer the period for which the records are made and the more areas for which reports are available, the more valuable is the accumulated information. For this reason the museum solicits the continued co-operation of its present correspondents and appeals for the assistance of others who may be able to supply information on changes in the wild life of their areas from year to year.

Literature

The following list of publications containing additional information on animal populations is given for the benefit of those who may wish further information on this important subject.

A study of the sharp-tailed grouse, by L. L. Snyder. Univ. Toronto Studies, Biol. Ser. 40. Reprinted as Contributions of the Royal Ontario Museum of Zoology No. 6. 1935.

Fluctuations in wild life, by Chas. Elton. Canada's Eastern Arctic, pp. 62-66, Dept. of Interior, Ottawa. 1935.

Fluctuations in numbers of ruffed grouse, *Bonasa umbellus* (Linne) with special reference to Ontario, by C. H. D. Clarke, Univ. Toronto Studies, Biol. Series No. 41. 1936.

Fluctuations in the numbers of varying hare (*Lepus americanus*), by D. A. MacLulich. Univ. Toronto Studies, Biol. Series No. 43. 1937.

The white-tailed deer in Ontario, by E. C. Cross. Rod and Gun in Canada. Feb., 1937.

The white-tailed deer crash, by E. C. Cross. Rod and Gun in Canada. May, 1938.

Animal Ecology, by Chas. Elton, Director of the Bureau of Animal Population, Oxford, is a fascinating account of the principles underlying animal populations. This 200-page book was published by the Macmillan Company in 1927.